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ABSTRACT

This manual provides information needed to meet specific standards for certification as a pesticide applicator. It summarizes the economically important diseases of field and forage crops such as corn, soybeans and alfalfa. Special attention is given to pesticide application methods and safety. (CS)

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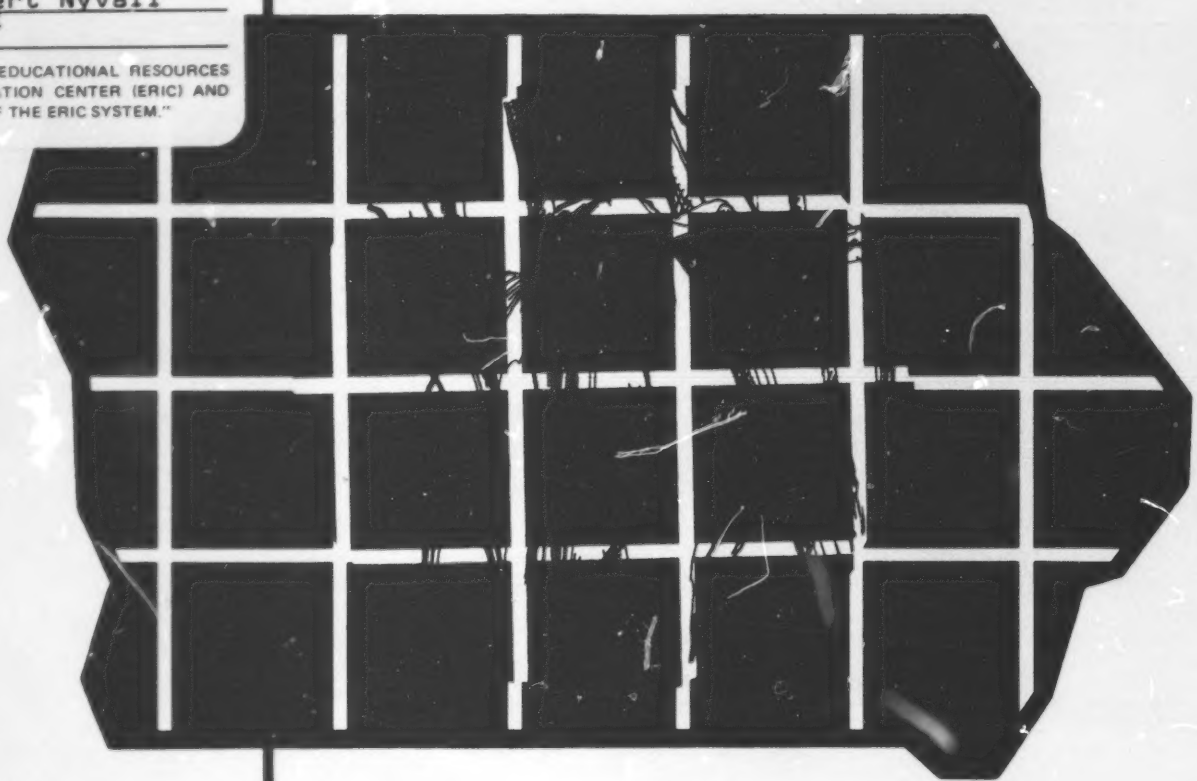
Iowa Commercial Pesticide Applicator Manual

CATEGORY 1C

AGRICULTURAL CROP DISEASE CONTROL



This manual is to be used for certification training in conjunction with the U. S. Department of Agriculture – U. S. Environmental Protection Agency manual, **Apply Pesticides Correctly,** EPA-335.

Cooperative Extension Service
IOWA STATE UNIVERSITY
Ames, Iowa 50011

CS-11
September 1975

This manual has been developed for individuals wishing to become certified in commercial pesticide applicator category 1C, Agricultural Crop Disease Control. It contains specific information that an individual must know before becoming certified in category 1C. The manual has been designed to supplement the general information contained in the core manual, *Apply Pesticides Correctly— A guide for commercial applicators* (plus an Iowa State University supplement) and should not be used for certification preparation without referring to the core manual as well.

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Prepared by Robert F. Nyvall, extension plant pathologist, and Stephen O. Ryan, pesticide training coordinator, who express appreciation to the University of Georgia for the use of source material.

CROP PRODUCTION

Modern, efficient agriculture produces crops on large, continuous acreages of land. Unfortunately, this type of agriculture encourages invasion of the crops by a wide variety of damaging pests. Therefore, production of these crops also requires the use of large quantities of pesticides to produce the quantity and quality of products needed by man. The productivity of modern agriculture is probably the most important underlying factor that gives the United States the highest standard of living in the world.

Agricultural crops may be divided into field and forage crops, vegetable crops and orchard crops. The necessity of pesticides for maximum production of high quality products has been documented many times by research and experience. The quality of products grown without the use of pesticides is generally much lower, and, in many instances, too low to be accepted for market.

Proper care must be exercised in applying pesticides to any crop. Methods of application vary widely with some being more dangerous to the applicator than others. For example, spraying orchard trees where the pesticide is applied above the head of the applicator is much more hazardous than applying chemicals to a low growing field or forage crop.

When planting crops, consideration should be given to the pesticides that will be used during the production season, the methods of application that will be employed and whether either of these considerations presents any problem for adjacent nontarget areas such as bodies of water, woodlands, urban areas and other crops that may become contaminated. Every effort should be made in planning to prevent these problems or at least minimize them.

Changes in registrations of old pesticide products or new product registrations may occur before each cropping season. Carefully read the label before using any pesticide.

Following is a summary of the economically important diseases of field and forage crops in Iowa.

Corn diseases

Each year, corn is subjected to several diseases. Some diseases are more serious in some years than other years, some are almost always present to some degree every year, and some have the potential to become serious.

The purpose of this pamphlet is to help farmers and other professional agriculturalists identify some of the more common corn diseases. No attempt has been made to include all corn diseases, only those that occur on a regular basis in the Midwest.

Prepared by Robert F. Nyvall, Charlie Martinson, and Dean Foley, Department of Botany and Plant Pathology. Edited by J. Clayton Herman.

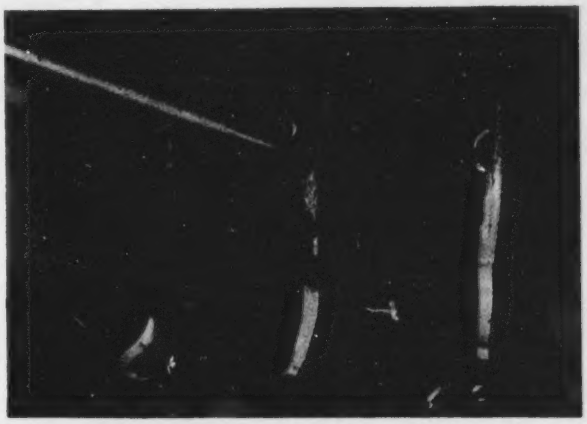
IOWA STATE UNIVERSITY of Science and Technology
COOPERATIVE EXTENSION SERVICE
Ames, Iowa October, 1974 . . . . . Pm-596

Seedling blight

Seedling blight is caused by several fungi. *Diplodia zeae* and *Gibberella zeae* are both soil-borne and seed-borne; *Pythium* spp. is soil-borne. Symptoms range from death of the embryo before germination to small lesions on roots and the lower part of the sprout. The mesocotyl, the first internode above the seed, is often rotted. This cuts off the food supply from the seed to the shoot as well as water and nutrients supplied by the true root system. If the adventitious roots from the first node above the mesocotyl are not well developed, the leaves wilt and the plants may die. Infected roots have brown to black, water-soaked flaccid lesions.

Seedling blight caused by *Pythium* spp. is prevalent in cold (50 degrees F is optimum), wet soil where corn germination is retarded, thus allowing fungi time to infect plants. Age of seed, mechanical damage to seed and genetic resistance affect seed rot and seedling blight. Seed stored for two or more years is more susceptible than seed produced the previous year. Mechanical damage during harvesting or processing affords avenues by which soil-borne fungi enter the seed.

Control: A fungicide seed treatment helps to protect seed against soil fungi and fungi on the seed. Fungicides have little effect against pathogens already established within the seed.

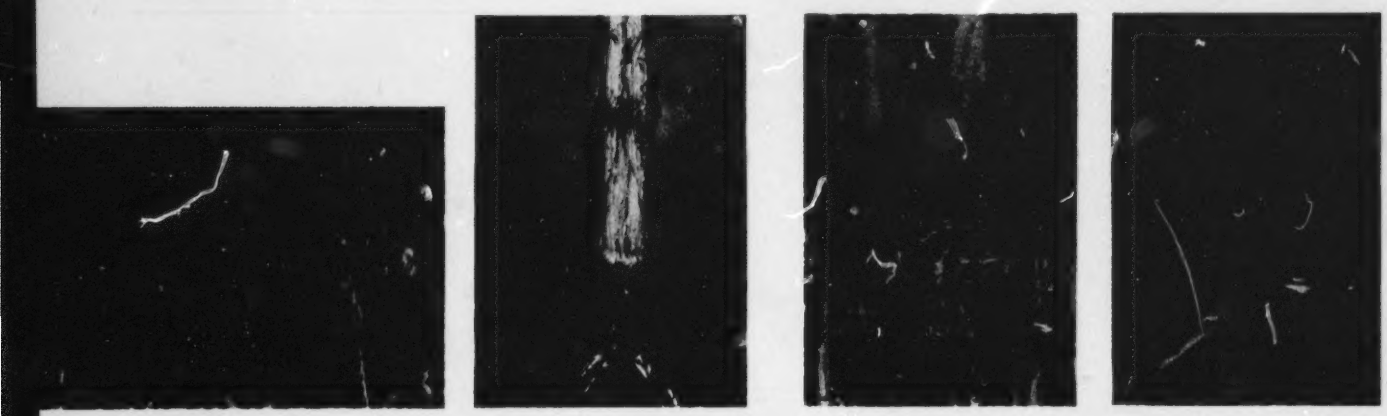


Seedling blight. Left, mesocotyl rotted off and roots discolored by *Pythium* spp. Center plant shows discoloration on mesocotyl caused by *Pythium* spp. Right, healthy plant.

Stalk rot

Stalk rot is caused by several fungi such as *Diplodia zeae, Gibberella zeae,* and *Fusarium moniliforme.* Initial symptoms are dark brown lesions that may appear near the nodes a few weeks after pollination. By mid-September they extend the length of the internode. The inside of the stalk is rotted and frequently displays a pink coloration. Only the vascular bundles are intact in severe cases. The rot often originates in the root and crown region of the plant. Infected plants succumb in September. Leaves die first giving the plants a bronzed to frosted appearance. Early death of the plant lowers yield. Further losses result when harvesters fail to pick ears from lodged stalks.

Some hybrids are genetically very susceptible to stalk rots. Stalk rot is more severe when the



Lodging due to stalk rot. Roots are first infected by fungi that grow up into the stalk. Symptoms are brown lesions near the nodes, as well as pink coloration and intact vascular bundles.

plants are affected by other diseases or pes' inadequate potassium nutrition compared to nitrogen availability, exceptionally high fertility rates, injury by early frost or hail, high plant populations, or if hot weather occurs after silking and tasseling. Early maturing varieties may lodge extensively if not havested promptly.

The fungi overwinter in various ways. *Diplodia zeae* overwinters as spores in a special fruiting structure or as mycelium (vegetative portion of fungi) in infected tissue. *G. zeae* overwinters as a fruiting structure in which spores are produced in the spring. *F. moniliforme* overwinters as mycelium either within infected refuse or seeds. During wet weather the discharged spores are wind-borne. Spores that land on corn plants are washed down into the leaf sheath where they germinate and grow into the stalk. Roots may be infected by fungi, causing root rot. Frequently, the fungi grow from the roots into the stalk thereby causing stalk rot. Wounds made by insects provide an entrance into the stalk for *G. zeae* and *F. moniliforme.*

Control: Using resistant full-season hybrids, balancing potassium and nitrogen, and planting at recommended populations are aids.

Pythium stalk rot

Pythium stalk rot is caused by the soil fungus *Pythium butleri.* The disease occurs during hot (90 degrees F or more), damp weather. Corn can be infected at any time during the growing season. Plants are usually infected in one internode within a foot of the ground and will twist over and fall to the ground but may still remain green and turgid for two to three weeks. This may be confused with other stalk rots.

Control by planting resistant hybrids.

Plant broken over near soil surface because of Pythium stalk rot.

Bacterial top rot

Bacterial top rot is probably caused by a soilborne bacterium. In Iowa, it is associated with hail damage and hot, damp weather. Plant tops become gray to brown with shortened internodes. The outside of the stalk may be brown to black and appear water-soaked. The inside of the stalk is brown, slimy to the touch, and smells like silage.

Control: None known, but some hybrids appear to be less susceptible than others.

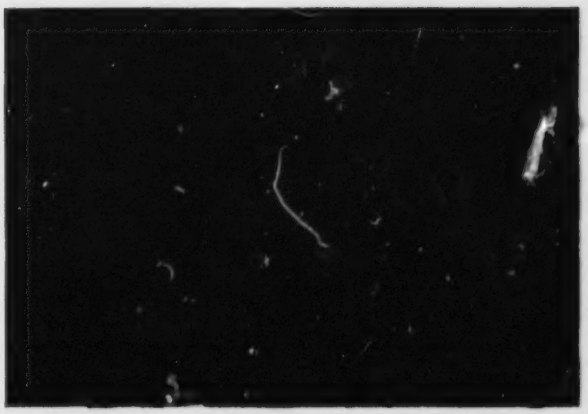
Plant affected by bacterial top rot.

Crazy top

Crazy top is caused by a soil-borne fungus *Sclerophthora macrospora*. A number of symptoms are evident such as tassel proliferation, excessive ear shoots, increased number of internodes above the ear, plant stunting, narrow straplike leathery leaves, excessive tillering, and complete suppression of tassel and ear formation.

The fungus overwinters as oospores either within infected tissue or in the soil. During periods of flooding, the oospores germinate and swimming zoospores are produced. The zoospores invade the growing point of the young corn plant. Wild grasses, sorghum and small grains are also attacked and may provide a means for the fungus to maintain itself in the absence of corn.

Control: None, except to insure proper soil drainage.



Tassel proliferation of a plant affected by crazy top.

Corn smut

Corn smut is caused by the fungus *Ustilago maydis*. The most conspicuous symptom is production of galls on stems, leaves, ears, and male flowers. All above-ground parts of the corn plant are susceptible, especially embryonic tissue. Stem galls result in various degrees of yield reduction and sometimes in a bending of the stem. Infection through silks results in smut galls in place of kernels. Seedling infection may kill the young plants, but this is rare.

Galls are at first covered with a glistening white membrane. The membrane eventually ruptures to expose a powdery, black mass of spores called teliospores that can withstand low temperatures. The teliospores overwinter either in the gall as part of the crop refuse or as single spores in the soil. In the spring, the teliospores germinate in the presence of moisture and penetrate the corn plant through stomata, through wounds caused by hail, detasseling, cultivation or blowing soil, and directly through cell walls. The fungus within the corn tissue stimulates cells to increase in size and number.

Control: Don't plant hybrids showing a high incidence of smut. Disease incidence is increased in fields high in nitrogen.

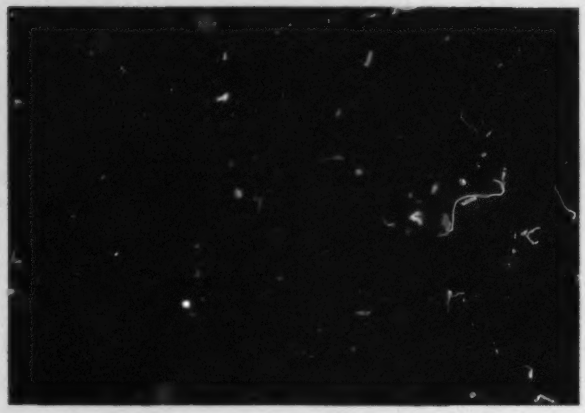
Corn smut gall.

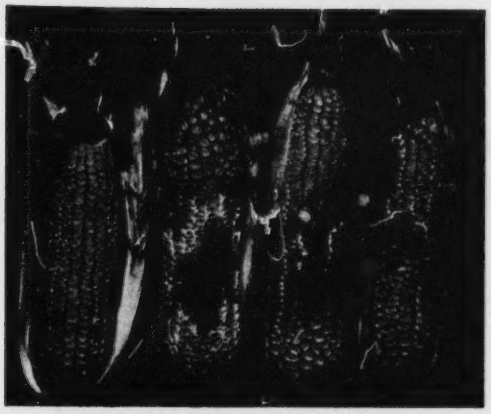
Southern corn leaf blight

Southern corn leaf blight is caused by the fungus *Helminthosporium maydis*. All above-ground parts of the plant are susceptible to infection. Symptoms on the leaf appear as tan, elliptical lesions (1/4 to 1/2 inch wide, 1/4 to 3/4 inch long) with a reddish-brown border frequently surrounded by a chlorotic area. Lesions may become so numerous that the leaf is killed.

Stalk and leaf sheath infections are initially purple spots that develop tan-gray centers (1/4 to 1 inch wide, up to 4 inches long). This infection may be confused with aphid feeding or another corn disease called purple leaf sheath spot. Ear infection occurs only with race T of the organism on T cytoplasm plants and it produces a gray-black lesion on the outer husk that extends into the kernels.

The fungus survives or overwinters as mycelium within infected corn tissue. Spores of the fungus are produced in the spring and are wind-blown to young corn plants. During infection, a toxin is produced by the mycelium of race T that kills susceptible T cytoplasm tissue in advance of the fun-





Lesions of southern corn leaf blight on leaves and ears.

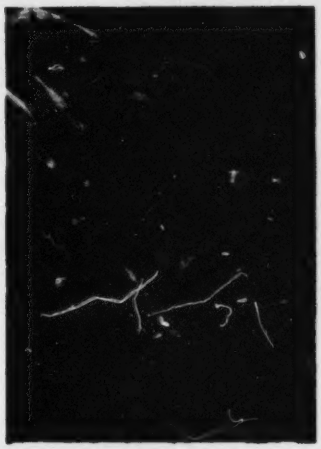
gus. The disease increases rapidly under favorable moisture and temperature—a spore will germinate, infect the plant, and produce new spores in 60 hours.

Control: Corn hybrids containing N cytoplasm are resistant to the toxin produced by race T but are still susceptible to the fungus. Plowing under infected crop refuse, planting a low plant population, and early planting aids control. Fungicides used to protect the plants must be sprayed on the leaves before the disease is severe.

Northern corn leaf blight

Northern corn leaf blight is caused by the fungus *Helminthosporium turcicum*. The lower leaves of susceptible corn hybrids are attacked first with symptoms usually appearing after silking. Symptoms are long, elliptical lesions (1 to 6 inches long), gray-green to tan in color and often of a target-like appearance. Although the outer layers of husks may be infected, the fungus does not grow through to the kernels. Infected plants may appear to be hit by frost and are often predisposed to common stalkrot. The fungus overwinters as spores and mycelium in infected crop residue. Spores are carried by the wind to corn leaves, and lesions appear 14 to 17 days after infection.

Control: Plant resistant hybrids. Fungicides may afford some protection, but their use may be limited by EPA regulations.



Northern leaf blight lesions.

Yellow leaf blight

Yellow leaf blight is caused by the fungus *Phyllosticta maydis*. Only leaves are infected. Bottom leaves are attacked first early in the growing season followed by a second infection of upper leaves about 3 weeks later. Symptoms are tan, oval to elliptical lesions (1/8 inch wide, 1/2 inch long), with a chlorotic or yellow margin. Fungal structures —that resemble tiny, black pimples called pycnidia and in which the spores are produced—appear in the middle of each lesion several days after infection and an extended moist period.

The fungus overwinters in infected crop tissue. In the spring, low temperatures (50 to 60 degrees F) and abundant moisture aid the development of spores within pycnidia. The spores are carried by wind to susceptible corn hybrids.

Control: Corn hybrids containing N cytoplasm

are more resistant than T cytoplasm hybrids. Clean tillage or plowing under of infected residue, crop rotation and good drainage are aids to control. Fungicides may give some protection but their use is limited to EPA regulations.

Bottom leaves are attacked first by the yellow leaf blight fungus. Right, oval to elongate lesions on leaves are typical of this disease.

Eyespot

Eyespot is caused by the fungus *Kabatiella zeae*. Infections occur on the leaves, leaf sheaths and outer husks of the ears about mid-July in Iowa. The resulting lesions are relatively small (1/8 to 1/4 inch), circular in shape and surrounded by a brown to purple ring and yellow halo. Although the entire plant may be infected, lesions are likely to be more numerous on leaves near the top of the plant where they may fuse together to form large necrotic areas.

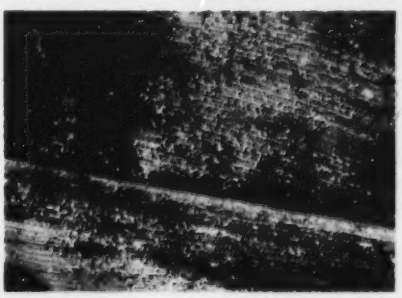
The causal fungus overwinters as mycelium in infected crop refuse. Lower temperatures (50 to 65 degrees F) are most favorable for development of spores that are wind-disseminated to healthy plants.

Control: Plant hybrids that are less susceptible.

Small, circular lesions are typical of eyespot.

Common corn rust

Common corn rust is caused by the fungus *Puccinia sorghi*. Symptoms are oval to elongate, raised brown to orange pustules that are scattered mostly over both upper and lower leaf surfaces. However, pustules may appear on any above-ground part of the corn plant. The pustules contain spores called urediospores which give them a powdery appearance. When rubbed, the spores are visible on a person's fingers as an orange powder. As the corn matures, the pustules become black as the urediospores are replaced with the black overwintering spores called teliospores. The uredio-



Common corn rust showing orange pustules.

spores are wind-borne and infect other corn plants. Development of the disease is favored by cool (66 degrees F optimum), humid weather.

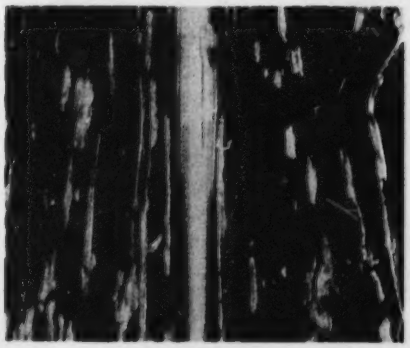
The causal fungus has five different spore stages; three are produced on corn and two on wood sorrel. Only the urediospore stage is important in Iowa and probably serves as the overwintering spore stage.

Control: Plant resistant hybrids.

Holcus leaf spot

Holcus leaf spot is caused by the soil-borne bacterium *Pseudomonas syringae*. Lesions usually are oval to rectangular. Initially, they are dark green and water soaked; later they become dry and turn light brown with sometimes a reddish margin. The bacteria survive within crop residue in the soil. During a storm the bacteria are splashed or blown onto plant leaves where they enter into the leaf either through stomates or wounds. Wounding is often the result of wind-blown sand particles. Symptoms of this disease, which appear 7 to 10 days after a storm, can be confused with other corn leaf blights. The disease does not cause serious losses.

Control: Plant hybrids that are less susceptible.

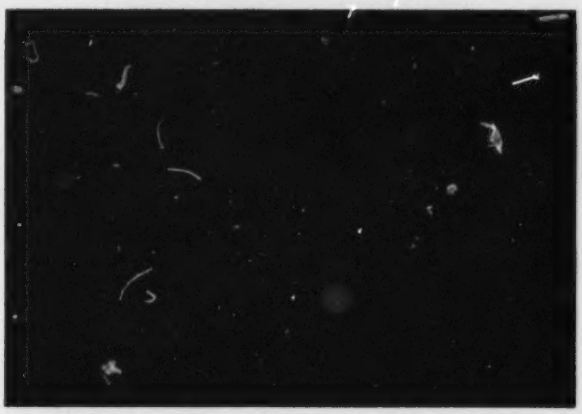


Lesions of holcus leaf spot.

Nebraska bacterial wilt

Nebraska bacterial wilt is caused by the bacterium *Corynebacterium nebraskense*. Symptoms are young plants that wilt and die, possibly from seed-borne bacteria. Older plants have large, elongated, water-soaked lesions on the leaves that are tan to gray in color. Bacterial ooze is often present on lesions and may appear as dark droplets of moisture. The disease is primarily present under irrigation. Little is known of how the bacterium is spread. Infected seed produces infected plants that die while still young; therefore, this means of spread is self eliminating.

Control: Use resistant hybrids. Plow under infected crop refuse to reduce inoculum.



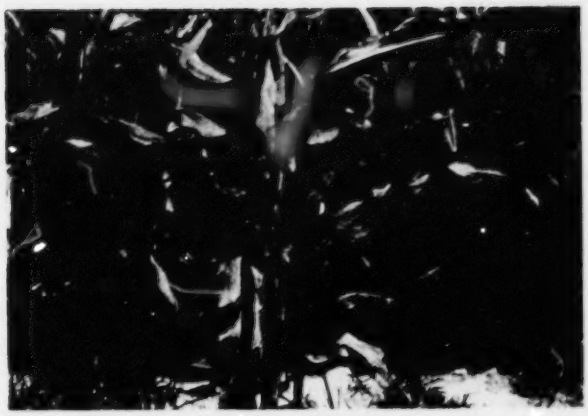
Lesions of Nebraska wilt on leaves.

Maize dwarf mosaic

Maize dwarf mosaic is caused by the maize dwarf mosaic virus. One of the earliest symptoms is shortening of the upper internodes, giving the plant a "feather duster" appearance. Another early symptom is alternating stripes of yellow and green on the leaves of young plants, giving a mosaic appearance. As the plants mature, the mosaic disappears and leaves become yellowish green with red blotches or streaks. These symptoms are most obvious on plants infected before silking; plants infected at silking or later may appear normal.

The virus also infects several wild and cultivated grasses, but Johnson grass is of the greatest consequence in Iowa because certain strains of the virus can overwinter in the plant. The virus is transmitted by several insects such as corn leaf aphid, melon aphid, green peach aphid, and the apple grain aphid from Johnson grass.

Control: Use resistant hybrids and destroy Johnson grass or other overwintering hosts.



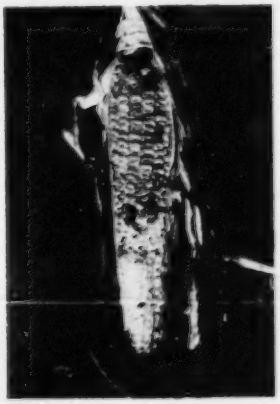
Reddish appearance of corn plant affected by maize dwarf mosaic. Right, alternate yellow and green stripes on leaves of a young plant infected by the virus.

Ear and kernel rots

Ear and kernel rots are caused by some of the same fungi that cause corn stalk rots.

Gibberella ear rot is caused by *Gibberella zeae*. Symptoms are white, pink, or red mold that grows over the ear usually beginning at the tip. Husks sometimes adhere to the ear due to fungal growth. *Gibberella zeae* has potential to produce a toxin that may be harmful to livestock, particularly swine. However, not all moldy corn may contain toxin.

Fusarium kernel rot is caused by *Fusarium moniliforme* and is one of the most widespread kernel rots in Iowa. Initial symptoms are pink discoloration of the caps of individual kernels scattered over the ear. These early infections are often established where corn earworms have fed or other injury has occurred. Frequently during continuous wet weather after corn maturity, the fungus will grow over the entire ear, thereby obscuring early symptoms. *Fusarium moniliforme* is not known to produce a toxin harmful to livestock when it is grown on corn.



Left, Fusarium kernel rot. Note pink discoloration of individual kernels. Right, Gibberella ear rot with fungal growth from ear tip and adhering husks.

Control: No hybrid or inbred is completely resistant or susceptible. Extended periods of wet weather that may delay harvest allow the causal fungi time to grow throughout the ear. Growth of the fungi stops in corn dried to 13 percent or less moisture content or corn treated with organic acid preservatives. However, any toxin that was produced prior to treatment will not be inactivated.

Gray leaf

Symptoms are gray areas on leaves that are caused either by a low night temperature followed by warm day temperatures or water-congested leaves resulting from dew and low night temperatures, then exposure to bright morning sun. The epidermis of the leaf separates from the adjacent cells, giving the leaf a gray appearance. Plants usually grow out of this condition without damage.

Gray leaf on young corn plant.

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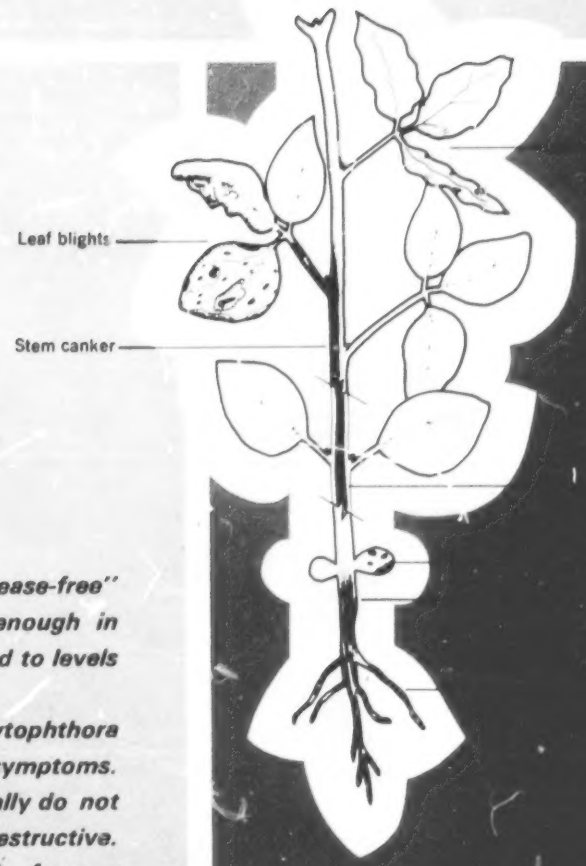
CONTROL OF CORN DISEASES

DISEASE	CAUSE	SYMPTOMS	CONTROL
Seed and seedling blight	Several soil fungi	See Pm-596	Fungicide seed protectants: Captan, Captan + Maneb, Thiram, Dexon, Terraclor + Terrazole, Maneb + Zinc, Busan, Sulfenimide. Use rates on package. Seed stored 2 or more years is more susceptible. Mechanically damaged seed is more susceptible.
Common stalk rot	Several soil fungi	See Pm-596	Resistant hybrids, balanced K and N. Plant recommended plant populations and use full season hybrids.
Pythium stalk rot	*Pythium butleri*	See Pm-596	Resistant varieties.
Bacterial top rot	Soil bacteria	See Pm-596	None known
Crazy top	*Sclerophthora mecrospora*	See Pm-596	Proper soil drainage.
Corn smut	*Ustilago maydis*	See Pm-596	Avoid susceptible varieties. High N makes plants more susceptible. Wounding makes plants more susceptible.
Southern corn leaf-blight	*Helminthosporium maydis*	See Pm-596	Plant N cytoplasm. Plow under infected refuse. Thinner plant populations. Early plantings. Use of protectant fungicides: Dithane M-45, Manzate 200 and Citcop 4-E before disease is severe. Use rates recommended on package.
Northern corn leaf-blight	*Helminthosporium turcicum*	See Pm-596	Resistant hybrids. Fungicides: Zineb, Maneb, Nabam, and zinc sulfate can be used **only** on sweet corn or foundation seed stocks. Use rates recommended on package.
Yellow leaf blight	*Phyllosticta zeae*	See Pm-596	N Cytoplasm. Plow under infected residue. Crop rotation. Good drainage. Zineb is used as a protectant fungicide on sweet and field corn. Dithane M-45 is used as a protectant fungicide on field, sweet, and popcorn in Florida **only**. Use rates on package.
Eyespot	*Kabatiella zeae*	See Pm-596	Plant less susceptible hybrids.
Corn rust	*Puccinia sorghi*	See Pm-596	Resistant hybrids.
Holcus leaf spot	Several soil bacteria	See Pm-596	Some hybrids less susceptible.
Nebraska bacterial wilt	*Corynebacterium nebraskense*	See Pm-596	Resistant hybrids. Plow under infected refuse.
Maize dwarf mosaic	Maize dwarf mosaic virus	See Pm-596	Resistant hybrids. Destroy Johnson grass and other overwintering hosts.
Ear and kernel rots	Several fungi	See Pm-596	None.
Bacterial wilt (Stewarts wilt)	*Bacterium stewartii*	Seedlings wilt and die. On older plants appearance of green-yellow streaks that turn brown and may have a feeding scar made by the beetle vector. Causal bacteria overwinter in several beetles.	Resistant varieties.

Soybean diseases



Soybeans once were considered a "disease-free" crop. They have now been grown long enough in the United States that diseases have increased to levels that can cause severe damage.

Many diseases such as bud blight and Phytophthora root rot display obvious and rather striking symptoms. Other diseases such as brown stem rot usually do not have outward symptoms but may be just as destructive.

The purpose of this pamphlet is to help farmers and other professional agriculturalists identify the most serious soybean diseases and to suggest practices that will help prevent these diseases. No effort has been made to include all soybean diseases, but only those that are among the most important in the Midwest.

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IOWA STATE UNIVERSITY of Science and Technology
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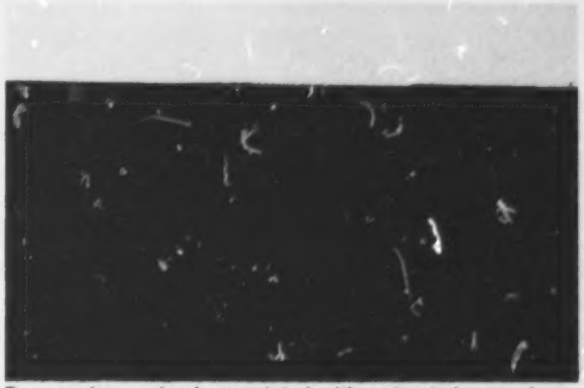
SEED QUALITY

Low seed quality whether due to physical, physiological, or pathological causes can make the seed more susceptible to damage by damping-off fungi. Damping-off means rotting of seeds or seedlings shortly before or after germination.

Mechanical damage may fracture the seed coat through which soil or seed-borne fungi can penetrate. Then the seed decays in the soil, frequently before germination.

Seed size substantially below average for a variety can cause reduced stand and seedling performance. Small seeds tend to be hard and take up less water. Such seeds germinate more slowly than normal sized seed and have reduced seedling growth.

Physiologically, seed quality may be lowered by storage conditions. Prolonged storage or storage of high moisture seed at high temperatures can reduce seedling vigor as well as stand. Age is somewhat indicative of seed quality; however, storage conditions have a greater effect than the time in storage. Soybeans stored at 14 percent moisture content or above will deteriorate rapidly even under good storage conditions, while soybeans containing 8 to 10 percent moisture will maintain quality under even less than ideal temperature. The germination percentage of deteriorated soybeans may not decrease even though the over-all vigor of the seed may have dropped to an extent that would render it unsuitable for planting.



Poor soybean stand associated with untreated second-year seed.

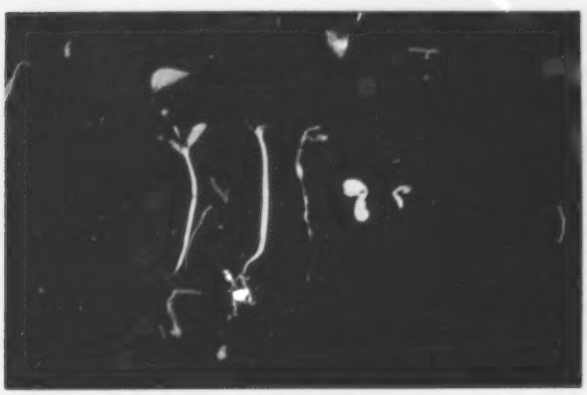
All of the above factors reduce germination. The longer a soybean seed stays in the soil without germinating, the longer it is exposed to infection by damping-off fungi that will ultimately rot the seed.

PYTHIUM ROT

Pythium rot is caused by two soil-borne fungi, *Pythium ultimum* and *P. debaryanum*. It may occur on soybeans at any time from seedling stage to end of flowering.

Soybean seeds planted in cold, wet soil are subject to attack by these seed decay or pre-emergence and post-emergence seedling blights. Seeds that do not germinate tend to be soft and overgrown with bacteria and fungi. Seedling blight results from infection of the seedling by Pythium fungi as it emerges through the soil. Seedlings that emerge often have well-developed cotyledons but lack a plumule from which the main stem normally develops. This condition is called "baldhead." Often the cotyledons will have necrotic spots. Losses from these phases of pythium rot are greatest when seeds used for planting are weak or low in vigor.

In the early infection of older plants, the stem above the soil line has a water soaked appearance. As the disease develops, this tissue becomes brown and sloughs off, giving the stem a shredded appearance. The outer tissues of the large roots are soft,



Pythium symptoms. Left to right: Necrotic lesion on cotyledon, "baldhead," brown lesions on rotted roots and cotyledons, and two germinated seeds that failed to emerge.

Pythium rot showing cotyledon (left) with necrotic spots versus healthy cotyledon (right).

brown and moist and also slough off easily. Roots are so badly rotted that most break off when pulled from the soil. Diseased plants stand singly or in small groups. The leaves have a wilted appearance and eventually the whole plant dies.

Pythium rot is favored by cold, wet soil early in the growing season or after a rainy period. Stand losses from seed rot and damping-off may be reduced by seed treatment with protectants, but in heavily infested soils, losses to older plants are also likely to occur. The Pythium fungi attack a wide variety of plants and therefore crop rotation is of little value. There are no resistant varieties. Seed treatment protects against seed decay, particularly when the seed is at least 2 years old or when germination is less than 80 percent.

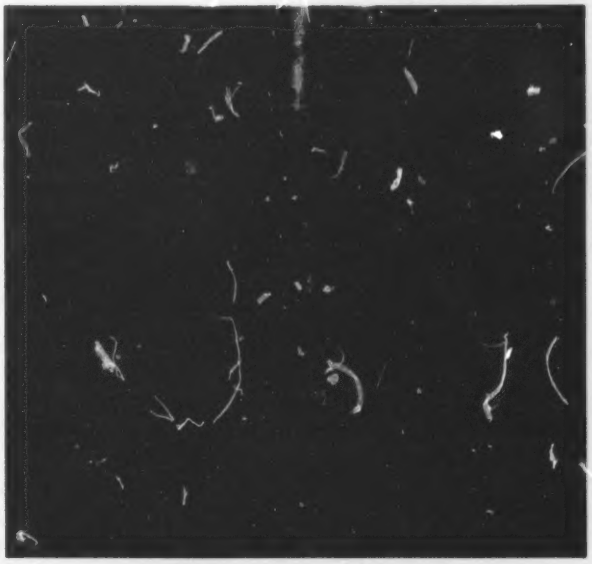
FUSARIUM ROOT ROT

Fusarium root rot is caused by a common soil-borne fungus, *Fusarium oxysporum*. Infected seeds may have poor germination resulting in either pre- or post-emergence damping-off or late emergence and stunted plants. The fungus causes dark brown lesions that are confined to roots and the lower portions of stems. The latter symptom may be confused with Rhizoctonia root rot. Root systems of severely infected plants may be completely destroyed. Wilting is most frequently observed on seedlings or young plants when roots are rotted and soil moisture is low. Older plants are seldom killed but they wilt when soil moisture is low and recover turgidity at night or when moisture becomes adequate.

Poor stands caused by the disease are usually associated with poor seed quality, heavy rains, soil compaction or soil flooding after planting.

Seedlings infected with *F. oxysporum* and showing signs of wilting or death of lower leaves should not be cultivated, if possible, until adequate soil moisture is available. When plants are cultivated, soil should be ridged around the base of the plants. This will promote development of roots from the stem base above the diseased area. These roots are not as easily infected by the fungus and help the plants to recover rapidly.

All varieties are susceptible and rotation is of little value in disease control.



Fusarium root rot showing brown lesions on lower stems and rotted roots.

RHIZOCTONIA ROOT ROT

Rhizoctonia root rot of soybeans is caused by the soil-borne fungus *Rhizoctonia solani*. The disease is first noticed by the presence of wilting and dead plants. Typical symptoms are decay of lateral roots, and localized reddish-brown lesions on the hypocotyl and lower stem that do not extend above the soil line. This symptom is best observed immediately after removing the plant from the soil. The discoloration is usually limited to the cortical layer of the main root and hypocotyl and does not extend into the center of the root or stem. Infected stems remain firm and dry. The disease pattern may occur as dead individual or groups of plants in a row or as circular areas distributed throughout a field.

The disease infects young plants when the soil is wet early in the growing season. The first symptoms appear as the weather warms up in the spring. Although the fungus usually becomes inactive after the middle of July, a serious epiphytotic has occurred as late as September in Iowa. This was during rainfall periods, each followed by cooling and subsequent warming. The wet, cool weather caused the fungus to become active and the warm weather placed a stress on the plant.

Since *R. solani* is a common soil fungus and is capable of surviving in the absence of soybeans, rotation is of little value in controlling root rot. All presently grown varieties are susceptible.

Rhizoctonia root rot. Note red lesions on lower stem.

PHYTOPHTHORA ROOT ROT

Phytophthora root rot is caused by a soil-borne fungus *(Phytophthora megasperman* var. *sojae)* that may attack the plant at any stage of development. It causes pre-emergence and post-emergence damping-off of the germinating seed and seedlings and also attacks older plants. When older plants become diseased, the first symptoms are yellowing and wilting of leaves accompanied by a dark brown discoloration of the stem that may extend from below the soil line upward into the stem and branches. A common secondary fungus, *(Fusarium* spp.*)*, frequently invades Phytophthora-killed tissues and is in evidence by a white mycelium on the stem surface. The tap root of infected plants is usually dark brown and the root system may be rotted. Plants may be reduced in vigor and become stunted resulting in yield reduction even in the absence of other obvious symptoms.

The disease is most common in low, poorly drained areas but may appear on higher ground during wet seasons. Damage is ordinarily more severe on heavy clay soils than on lighter soils. Older plants may become infected later in the growing season, occasionally even under dry conditions. Initial infection of lateral branches also may occur. In such cases the fungus eventually grows into the stems and, since the roots may not be rotted, the disease may be confused with stem canker.

The disease pattern varies within a field. Frequently it may be roughly circular, corresponding to the poorly drained areas, or it may occur as dead or dying individual or groups of plants in a row. Infected plants often may be found more easily in end rows than within a field.

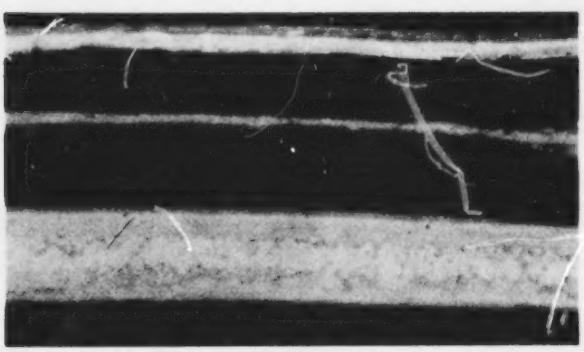
Phytophthora megasperman var. *sojae* survives from growing season to season in soil or in crop refuse buried in soil. How the disease initially enters a field is unknown. Some possibilities are the spores may be blown with soil particles by the wind from area to area; the fungus may be present on crop refuse associated with seed; or *P. megasperma* var. *sojae* may be parasitic on weed hosts.

A number of varieties are resistant to this disease.

Phytophthora root rot showing brown discoloration on stem extending above soil line.

BROWN STEM ROT

Brown stem rot is caused by the soil-borne fungus, *Cephalosporium gregatum.* Infection of soybeans by *C. gregatum* occurs through the roots and lower stem early in the growing season. Since the diseased plant does not usually display outward disease symptoms, the only positive way to tell if plants are infected is to split the lower 6 inches of the stem 10 to 30 days before the soybeans mature. Healthy stems have white tissue in the center; infected tissue is brown. The browning (indicative of fungal growth) progresses upward in the stem during the growing season, moving most rapidly during cool weather. Warm weather suppresses the disease. Severely diseased plants may lodge.



Stems split to show internal discoloration caused by brown stem rot (top) and center of a healthy stem (bottom).

Leaf symptoms are not ordinarily a reliable diagnostic tool since they are relatively uncommon and may be confused with other leaf disorders. Leaf symptoms develop when infected plants are subjected to high temperatures or drouth stress following a period of cool weather. Tissue between the veins turns brown and dries rapidly, usually about 3 weeks before maturity, while tissue adjacent to the veins remains green a few days longer. Eventually the whole leaf dies. An infected field of soybeans turns brown in contrast to the yellow-green color of a normally maturing field. There is no evident pattern of disease in an infected field. Since the disease is usually difficult to identify by visible outward symptoms, most growers blame a low yield on other causes.

Brown stem rot may cut yield by as much as 25 percent if all plants in a field are infected. Yield reduction will be proportionally lower in less seriously infected fields. Soybeans following soybeans, alfalfa, or red clover may increase incidence of

brown stem rot in a field since *C. gregatum* is also pathogenic to alfalfa and red clover.

Cephalosporium gregatum survives from one growing season to the next in infected crop residue in the soil. With decomposition of infected residue the fungus cannot survive in the soil. Therefore, to control brown stem rot, soybeans should be rotated with crops other than alfalfa or red clover. Fields known to be infested with the fungus should not be planted to soybeans for at least 3 years. The end rows of corn fields should not be planted to soybeans.

All soybean varieties currently grown in the Midwest are susceptible.

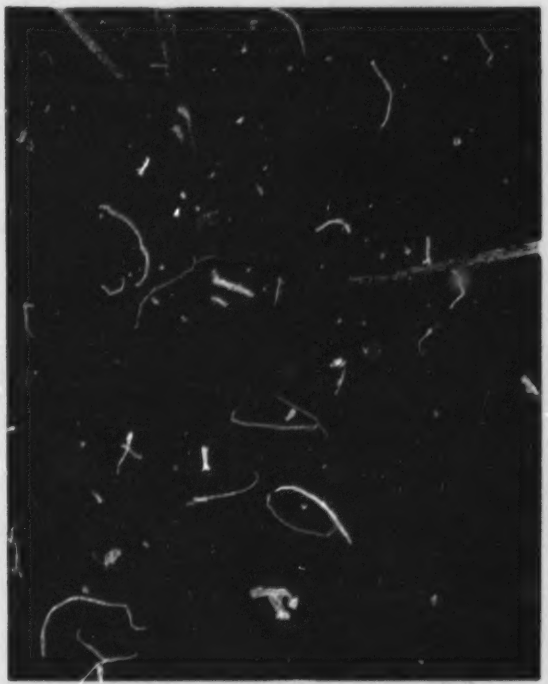
STEM CANKER

Stem canker is caused by a fungus *Diaporthe phaseolorum* var. *caulivora*. The disease usually appears after mid July and continues until plant maturity. An indication of the disease is the presence of dead plants with leaves still attached. Initially, the fungus causes a lesion that is light brown and slightly sunken. The lesion usually appears at the base of a branch or leaf petiole on one side of a stem. Eventually, the lesion girdles the stem and the upper part of the plant is killed. These lesions usually are found near the soil line but they may occur higher on the stem. Symptoms of this disease may be confused with those associated with Phytopthora root rot.

The fungus is seed-borne, and spores produced on infected cotyledons may infect developing seedlings. Sexual fruiting bodies called perithecia develop and are visible as tiny black dots on dead stems in the field during the winter. Spores produced in perithecia in the spring may also infect healthy plants.

To control stem canker, plant seed from disease-free fields. Fall plowing of soybean fields to hasten decay of infested stubble is an effective disease control practice but it is not feasible because of severe soil erosion that may occur on land following soybeans.

All varieties currently grown are susceptible to stem canker.



Stem canker lesion girdling a soybean stem.

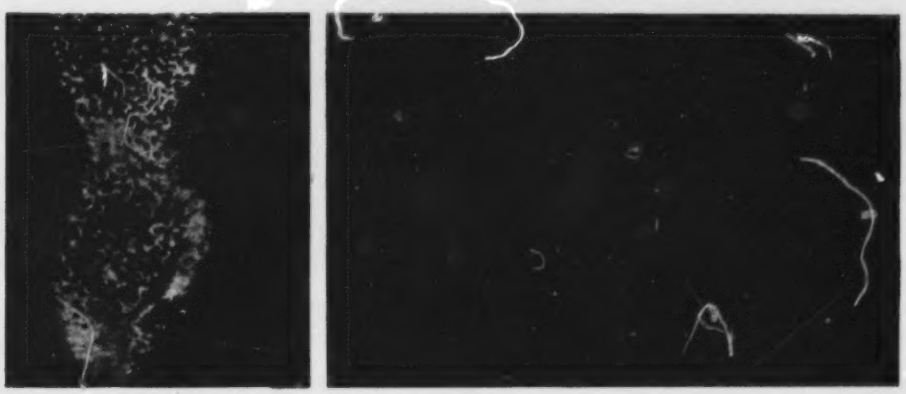
POD AND STEM BLIGHT

Pod and stem blight is caused by the fungus *Diaporthe phaseolorum* var. *sojae*. This is a disease of stems and pods on plants nearing maturity.

Symptoms are numerous, small, black fruiting bodies called pycnidia that are on stems and pods. The pycnidia are in rows on the stems but are scattered over the pod.

Frequently, seedlings grown from infected seed will damp-off soon after germination. Pod and stem blight is favored by periods of wet weather that enable the fungus spores to be produced in the pycnidia and spread to and infect other plants. The disease is seed-borne and the fungal spores also overwinter on infected refuse.

Control by plowing under crop refuse, planting seed from disease-free fields, and crop rotation.



Black pycnidia of pod (left) and stems (right) are symptoms of pod and stem blight.

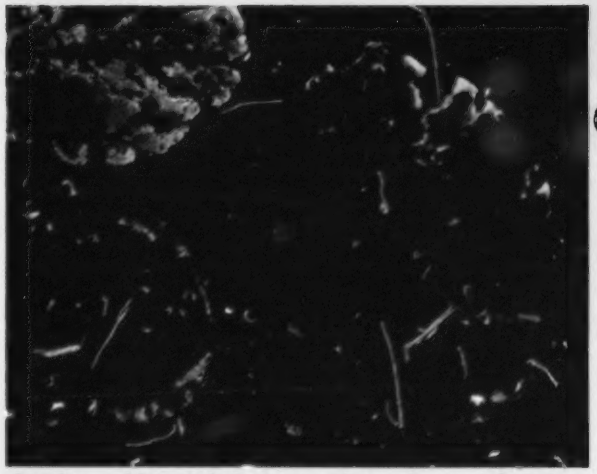
BROWN SPOT

Brown spot is caused by a fungus *Septoria glycinea*. This disease appears on the first pair of leaves (primary) in the spring. Symptoms are angular red to brown spots that vary from the size of a pinpoint to one-fifth inch in diameter and are more pronounced on the under leaf surface. Infected leaves become yellow and are prematurely shed. As the plants grow, fungus spores produced on the primary leaves may spread and infect the trifoliate leaves, stems and pods. Defoliation of the plant occurs from the bottom upward, and the lower half of stems of diseased plants may be bare of leaves before maturing.

The fruiting bodies (pycnidia) of the fungus are borne in leaf and stem tissue. Spores produced within a pycnidia are discharged during warm, moist weather and start new infections on other plants. Areas with poor drainage favor spread of the disease.

The fungus overwinters on infected crop residue in the field and is seed-borne. Greatest disease incidence occurs when soybeans follow soybeans in the same field.

Control by crop rotation, keep a field known to be infested with *S. glycinea* out of soybeans for at least a year. Soybeans from diseased fields should not be used for seed. No soybean varieties currently grown in the Midwest are resistant.



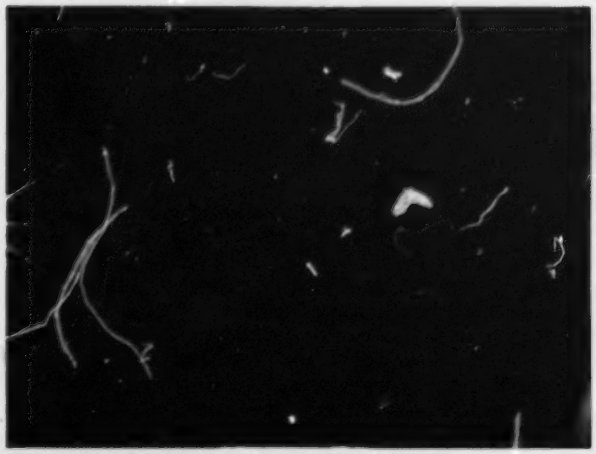
Angular red-brown lesions on primary leaves infected by brown spot.

BACTERIAL PUSTULE

Bacterial pustule is caused by the bacterium *Xanthomonas phaseoli* var. *sojensis*. First symptoms of this disease are small yellow-green spots with brown centers that appear on the leaves. These spots are most conspicuous on the upper surface of the leaf. A small raised pustule usually develops at the center of the lesion, especially on the lower leaf surface. Spots may merge, forming larger dead areas in which the tissue may fall out, giving the leaf a ragged appearance. The pustules eventually rupture and dry. At this latter stage, the disease may become confused with bacterial blight. The pustule and the absence of a water-soaked appearance before the spot turns yellow distinguishes bacterial pustule from bacterial blight.

Bacterial pustule is a warm weather disease, usually appearing about mid-July in Iowa. Leaves of plants are infected by bacteria splashed from the soil or nearby diseased plants. The bacteria are carried over from year to year in infested residue and may be borne on seeds.

Some varieties are resistant.

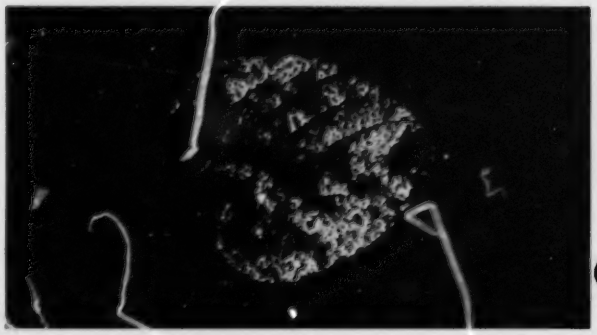


Raised pustules develop in the center of lesions on underside of leaf.

BACTERIAL BLIGHT

Bacterial blight is caused by the bacterium *Pseudomonas glycinea*. This is one of the first leaf spot diseases to appear on young plants in the spring and is one of the most widespread soybean diseases in Iowa.

The causal bacteria are splashed from soil or nearby diseased plants to the lower leaves of healthy plants. Leaf symptoms start as small, angular, water-soaked spots that eventually turn yellow then brown as the tissue dies. The brown central area of the spot is surrounded by a yellow

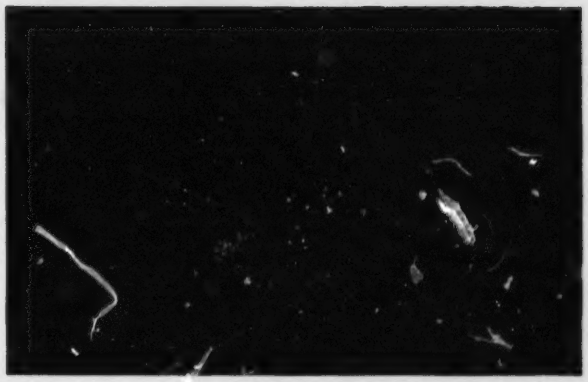


Initial small wet spots of bacterial blight become yellow > then brown surrounded by yellow halo. . .

border. As the spots increase in size, large areas of the leaf may fall out due to wind, rain or insects giving a ragged appearance. Leaves may drop off severely infected plants. While the disease is most commonly found on leaves, it can also infect stems, petioles and pods.

Bacterial blight develops most extensively during cool, wet weather, but appears to a limited extent throughout the summer.

The causal bacteria are seed-borne and also overwinter in dead leaves. Control by not planting seed harvested from infected fields. All varieties currently grown in the Midwest are susceptible.



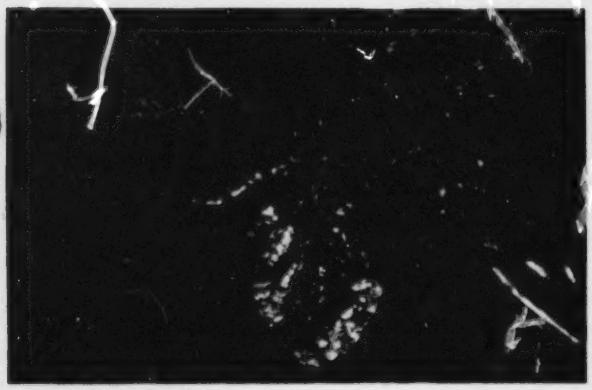
. . .Leaves appear ragged as lesions fall out. >

DOWNY MILDEW

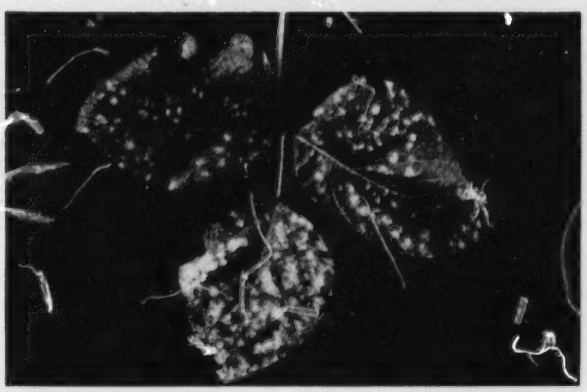
Downy mildew, caused by the fungus *Peronospora manshurica,* is one of the most common soybean diseases in the United States. Symptoms of the disease in the early stages are indefinite, yellow-green areas on the upper leaf. As infection progresses, the diseased areas become grayish brown to dark brown and are surrounded by yellow-green margins. Severely infected leaves fall prematurely. A gray fungus growth develops on the lower side of these diseased areas.

Spores produced by the fungus spread the disease from plant to plant. Spores develop within leaf tissue and overwinter in the fallen leaves, providing a source of infection for next year's crop. The fungus also grows within the plant, invades the pods and covers some seeds with a white crust of spores. When these seeds are planted, a small percentage of seedlings are infected and provide centers of infection.

Resistant varieties are being developed.



Upper leaf showing lesions of downy mildew.

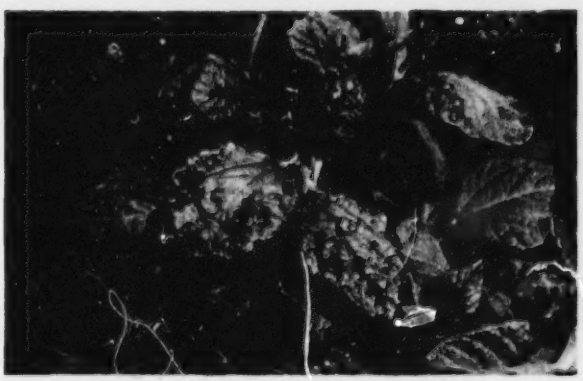


Lower leaf showing lesions of downy mildew with **Peronospora manchurica** sporulating.

SOYBEAN MOSAIC

Soybean mosaic, probably the most common virus disease of soybeans, may reduce yield up to 25 percent. Soybean varieties differ widely in their range of susceptibility to soybean mosaic. All plants of a variety grown in the South were recently found infected by the soybean mosaic virus. In general, commercial soybean varieties are less susceptible than large-seeded varieties, but no immune varieties are known.

When very susceptible varieties are infected, the first disease symptom is a yellowish vein-clearing that develops in the small, branching veins of the



Puckering and distortion of leaves infected by soybean mosaic. >

developing leaves. This symptom appears 6 to 14 days after infection. Rugose (crinkled) symptoms usually appear on the third leaf formed after infection. If infected plants are grown under cool conditions, the rugose symptoms increase in severity on successive leaves, and the characteristic mosaic pattern of alternate light and dark green patches of leaf tissue may appear. The mosaic symptom is much more obvious on some varieties than others.

If infected plants are grown under warm conditions (88 degrees F. and above), symptoms are masked and leaves develop normally. Symptoms may vary from essentially normal-appearing leaves, in which the veins are particularly deep in the lamina, to regose leaves, in which portions of the upper surface have become invaginated into visicles. Leaves become leathery to the touch, coarse and brittle near maturity. Severely infected leaves may be quite narrow and have a "willow leaf" appearance. There may also be seed discoloration.

The virus is transmitted by aphids. There is no practical control measure for this disease.

BUD BLIGHT

Bud blight is caused by the tobacco ringspot virus and occurs mainly in the Midwest. The disease is sporadic, appearing only in certain years. Losses of 25 to 100 percent have been reported. The disease is frequently more severe adjacent to legume-grass pastures or fence rows, where perennial plants act as virus reservoirs for transmission to soybeans. Grasshoppers, thrips and nematodes can transmit the virus.

Symptoms of bud blight vary with the stage of development at which plants become infected. When plants are infected before flowering, the apical bud and shoot turns brown, curves downward markedly, and becomes dry and brittle. The youngest leaf often develops a rusty flecking. The plant is dwarfed and produces virtually no seed. Sometimes the inside of the stem below the blighted terminal bud is discolored, most often at the nodes. When infected during flowering, plants produce mainly small undeveloped pods. Infection after flowering results in poorly filled pods that have a conspicuous dark blotching. Many of these pods fall to the ground. Infected plants usually remain green after normal plants have matured and thus are easily found in the fall. Many strains of the virus exist and some cause severely dwarfed, barren plants.

Tobacco ringspot virus has a very wide host range. Several legumes (alfalfa, red clover, sweet clover) and common weeds (morning glory, pigweed, horse nettle, ragweed and sunflower) may act as sources of inoculum.

Dwarfed plant with rusty flecking on leaves and pods caused by tobacco ringspot virus, known as bud blight in soybeans.

No bud blight-resistant varieties of soybeans are known. The most practical control measure is elimination of sources of the infection in nearby fence rows and established perennial host plants in meadows and pastures. Volunteer soybeans should also be eliminated.

IRON CHLOROSIS

Iron chlorosis is a disorder that may occur in soybeans grown in soil with a pH of 7.8 and higher. Under these conditions, iron in the soil becomes unavailable to the plant. This can be a problem with soils such as the Clarion-Webster soil association area in Iowa and other soils in the Midwest with similar properties.

Typical symptoms initially are interveinal areas of leaves becoming chlorotic while the veins remain green. Eventually the whole leaf becomes chlorotic and finally necrotic. At this latter stage, the symptoms may be confused with damage caused by some herbicides.

Frequently, when iron chlorosis is not severe, the leaves at the top of the plant will display typical iron chlorosis symptoms for awhile then become a normal green. Iron chlorosis usually occurs in irregular areas throughout a field. Plants in the center of an affected area may be stunted or dead and plants towards the periphery may be only chlorotic.

< Leaves of plants suffering from iron chlorosis have yellow interveinal area with green veins.

AND JUSTICE FOR ALL

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CONTROL OF SOYBEAN DISEASES

DISEASE	CAUSE	SYMPTOMS	CONTROL
Pythium seed and seedling rot	*Pythium ultimum* *Pythium debaryanum*	See Pm-528	Fungicide seed protectants: Captan, Chloranil, Chioroneb, Terrazole, Maneb, PCNB, and Thiram. Apply at rates recommended on package.
Fusarium root rot	*Fusarium oxysporum*	See Pm-528	Infected seedlings should not be cultivated until adequate soil moisture is available.
Rhizoctonia root rot	*Rhizoctonia solani*	See Pm-528	None
Phytophthora root rot	*Phytophthora megasperma*	See Pm-528	Resistant varieties
Brown stem rot	*Cephalosporium gregatum*	See Pm-528	Leave field out of soybeans, alfalfa, and red clover for 3 years.
Stem canker	*Diaporthe phaseolorum* var. *caulivora*	See Pm-528	Plant seed from disease-free fields. Plow under infected residue. Crop rotation.
Pod and stem blight	*Diaporthe phaseolorum* var. *sojae*	See Pm-528	Fungicide seed protectants help prevent seed-borne damping off. Use fungicides listed for Pythium seed and seedling blight. Benomyl can be foliar-applied to soybeans used for all purposes. Follow directions and recommended rates on packages. Plow under infected refuse, rotate crop and use disease-free seed.
Brown spot	*Septoria glycinea*	See Pm-528	Use only disease-free seed. Crop rotation.
Bacterial pustule	*Xanthomonas phaseoli* var. *sojensis*	See Pm-528	Some varieties less susceptible than others.
Bacterial blight	*Pseudomonas glycinea*	See Pm-528	Protectant foliar fungicides containing 8% copper. Do not plant seed from infected fields. Crop rotation.
Downy mildew	*Peronospora manshurica*	See Pm-528	Resistant varieties but none adapted for Iowa.
Soybean mosaic	Soybean mosaic virus	See Pm-528	Use seed from disease-free field.
Budblight	Tobacco ringspot virus	See Pm-528	None

Plant Disease Control

Crown and Root Diseases of Alfalfa

Crown and root diseases caused by soil-borne fungi, bacteria and nematodes reduce alfalfa yields and stands in Iowa. Because the diseases attack underground portions of the plants, damage is often hard to recognize. Initial disease symptoms are in the crowns and roots and are not immediately obvious unless the plants are dug up.

As the ailments progress, infected plants appear unthrifty, wilt and die. Finding dead plants is usually the first clue that something is wrong in an alfalfa field. Some typical problems that may predispose alfalfa plants to disease are:

1. Varieties that are relatively low in winterhardiness;
2. Acid soils, to which this legume is very intolerant;
3. Poor surface and subsurface drainage of the soil;
4. Low levels of soil nutrients other than nitrogen;
5. Frost heaving, particularly in heavier soils;
6. Areas of reduced sunlight;
7. Absence or low level of populations of suitable *Rhizobium* species; and
8. Numerous insect pests and many damaging diseases widely distributed where alfalfa is grown.

Bacterial Wilt

Although there are others, bacterial wilt is probably the most common cause of alfalfa winterkill in Iowa. Infected plants are stunted, have small leaves and stems and recover slowly after cutting. Diseased plants are often bushy and have multiple stems. After being stunted, leaves turn yellow. Infested fields become progressively less productive after each cutting. Plants may die during the second or third winter after planting.

The disease progresses rapidly and kills plants during hot, dry weather. Taproots of newly infected plants often show a discolored, dotted or ringed pattern if cut in half. The central woody cylinder of roots and crowns becomes discolored during later stages of disease. Seriously infected plants show a complete rotting of the roots. Stands frequently become so thinned by the third year that they are no longer worth maintaining.

Bacterial wilt is more serious in low, poorly drained fields. The causal bacterium, *Corynebacterium insidiosum*, survives in living or dead alfalfa tissue in the soil. It is spread by surface water, tools, or infected hay. It is not seed-borne. Bacterial wilt infects both roots and crowns during the spring and early summer. The bacteria enter plants through wounds caused by winter injury or mechanical damage resulting from mowing or grazing.

Many alfalfa fields in Iowa are infested with bacterial wilt. The only practical control measure is to plant resistant varieties. Since the disease is most serious after the second year of the stand, plant early dormant, winterhardy, wilt-resistant types if the stand is used longer. If the stand will be used for only two years, plant any of the resistant varieties or the susceptible Flemish varieties. Some Flemish varieties now available show limited bacterial wilt resistance.

Phytophthora Root Rot

Phytophthora root rot infects plants at all stages of development. Affected plants appear wilted or stunted with yellowed, often reddish-blue leaves after 10 to 14 days of wet conditions. It is caused by a fungus, *Phytophthora megasperma*, a soil-borne organism that causes seedlings to damp off before or after emergence. Crowns and taproots of older infected plants become soft, water soaked, and turn yellow to tan at any depth to about 20 inches. When decay is near the crown, plants can

Prepared by Robert F. Nyvall, extension plant pathologist; Don C. Norton, professor of botany and plant pathology; and Frank W. Schaller, extension agronomist.

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be pulled up easily, leaving taproots in the soil. By the time these symptoms occur, root rot has progressed so far that plants do not recover. However, if enough taproot remains when the soil becomes drier, progress of rot ceases and the plants recover. The root systems of these plants are shallow and are more subject to drouth.

This disease occurs in low areas where water collects, on slopes where drainage is poor and in waterways. During periods of heavy and prolonged rainfall, this disease can be expected to be a problem in all alfalfa varieties in poorly drained soil. Adequate soil drainage should prevent extensive root rot damage in alfalfa.

Fusarium Wilt

Only established plants are infected by Fusarium wilt. The first evidence of this disease is a rapid wilting of stems on one side of the plant. Infected leaves and stems become bleached, often showing a slight pink color. The rest of the plant dies during the next 2 or 3 months.

Alfalfa growing in fields with low fertility, poor drainage and high water table is susceptible to Fusarium wilt. The causal soil-borne fungus, *Fusarium oxysporum*, weakens infected plants, reducing yield, quality of hay and longevity of the stand.

Symptoms of Fusarium wilt are similar to those of bacterial wilt. However, the diseases can be distinguished by examining the roots during early stages of the disease. Plants infected with bacterial wilt show a ring of discoloration in the outer woody tissues when the roots are cut in half. Plants infected with Fusarium wilt show brown streaks in the central core when the roots are split open. These enlarge and eventually merge, discoloring the entire outer portion of the root cylinder and killing the plant. Greatest losses occur during the first two years of a stand. The disease kills scattered plants during remaining years of a stand.

Rotation is of little value as a control measure because the Fusarium fungus survives in the soil during extended periods when fields are held out of alfalfa. There are no known resistant varieties.

Cross sections of alfalfa roots show differing discoloration caused by bacterial wilt. Stem at lower right is healthy.

Fusarium Root Rot

Fusarium root rots are diseases of seedling and older plants. They are caused by several species of the fungus Fusarium. Seedlings may be killed (damping-off) before or after emergence from soil, particularly during periods of warm, wet weather. Fungi enter roots of young plants by direct penetration or through wounds caused by feeding of nematodes, insects, or other agents. Growth of fungi may be limited to small areas of wounded or normal cells on root surfaces. Eventually, the fungi may grow into vascular tissue when plant vigor is reduced. Often, the fungi cause lesions which girdle taproots. Infected plants are usually stunted, leaves are yellow and have a bleached appearance. Plants lack vigor, wilt and die.

Increased frequency of cutting increases root rot. Cutting late in growing season, thereby reducing stored food reserves before winter dormancy, is a poor practice. Weeds provide competition and weaken alfalfa plants which make them more susceptible to root rot pathogens.

Most alfalfa varieties are susceptible to Fusarium root rots. Teton, a pasture type alfalfa, does demonstrate some field tolerance to a few of the *Fusarium* species causing root rot. Rotation is of little value as a practical means of reducing fungi populations in soil because of the ability of Fusarium to parasitize a number of different plant species or to live on dead plant material in soil.

Pythium Seed Rot and Seedling Blight

Thin or uneven stands of alfalfa often result from seed rot and seedling blight diseases caused by the fungus *Pythium*.

Cool, wet weather in the spring favors development of seed rot and preemergence seedling blight. These diseases are characterized by soft rotting of plant tissues. This disease is inconspicuous and rarely observed by the grower. Post-emergence seedling blight is characterized by young plants

being attacked anywhere below ground line. Initially affected stems or roots become water-soaked in appearance and then dry to thin, dead tissue. The entire seedling dies and dries up.

Nematodes in Alfalfa

Nematodes are generally more serious on perennials than annuals in Iowa and the same applies to nematodes attacking alfalfa. Little damage usually results the seeding year but the longer the stand is maintained, the more damage one can expect. Plants become stunted and stands thin, often in patches. Yields are reduced and the crop may generally decline. Damage may be noticed in the second year, but it often does not become serious until the third or fourth year. Although all alfalfa fields in Iowa are infested with plant parasitic nematodes, surveys indicate that nematode damage can usually be seen in about one field out of ten. This damage may occur in patches from a few yards in diameter to several acres in size.

Nematodes are a kind of roundworm. Most of the plant-parasitic ones live in the soil, feed on roots and can be seen only with a microscope. There are many kinds of plant-parasitic nematodes, but those that only attack the roots are more of a problem on alfalfa. The dagger nematode, *Xiphinema americanum*, is one of the most widespread and most serious. The northern root knot nematode is found sporadically on alfalfa in Iowa and can be damaging. Over the years, however, this nematode is probably kept in control by the annual planting of more than 10 million acres of corn, which is a nonhost. The root lesion nematode, *Pratylenchus*, is also widespread in Iowa and can damage alfalfa.

Besides injuring alfalfa, nematodes can so weaken the roots that the plants become more susceptible to some crown and root rot organisms. Many of these crown and root rotting organisms would not become established and severe in alfalfa if nematodes or some other agents did not weaken the plants first. Thus, the indirect effects of nematodes may be even greater than the direct effects.

At present, the best way to minimize nematode damage on alfalfa is to maintain healthy plants by good cultural practices. These include raising two to three years of annuals between alfalfa croppings, and adequate fertility to stimulate root growth which will help counteract the damage to the roots caused by the parasite. Plants on lighter soils are more apt to be damaged than those grown on heavier soils. In the longer cropping systems, however, severe damage can result to plants grown in clay loams.

Controlling Root and Crown Rots

Measures that will help prevent root and crown rots of alfalfa in Iowa include:

1. Planting only high-yielding, proven, adapted varieties;
2. Planting in well-prepared seedbeds in well-drained soils;
3. Testing soil and fertilizing to maintain plant vigor and growth;
4. Preventing overgrazing which weakens alfalfa stands; and
5. Giving alfalfa plants a four to six-week rest period each year in September and early October.

Phytophthora root rot often occurs in low, poorly-drained fields and in heavy soils. It attacks plants at all stages of growth.

This stand of alfalfa was thinned out by winterkill, commonly caused by bacterial wilt which weakens growing plants.

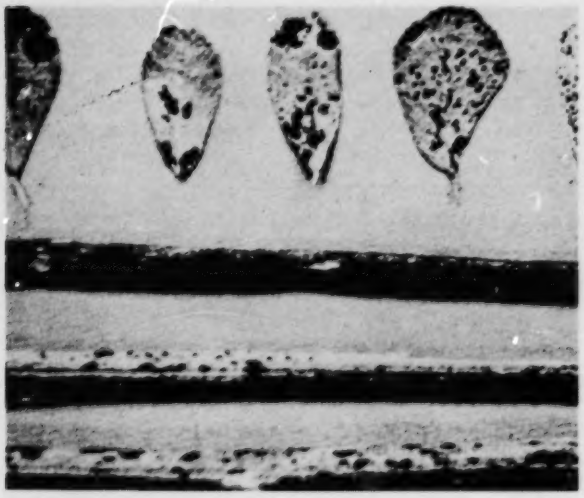
Stem and Leaf Diseases of Alfalfa

Prepared by Robert F. Nyvall, extension plant pathologist.

Approximately 2 million acres of alfalfa are cut annually for hay in Iowa. Diseases affecting the leaves and stems reduce the yield of hay and cause loss of plant vigor. Diseased plants are more susceptible to weather injuries which may result in winter kill. Greatest disease losses occur during seasons when rains are frequent and fields are harvested late.

SPRING DISEASES

Spring Black Stem



Spring black stem is caused by the fungus *Phoma medicaginis*. This disease occurs annually and is one of the most prevalent foliage and stem diseases of alfalfa. Cool, wet weather, especially in the spring, favors infection of plants by the fungus. Leaves, stems, and in some cases pods are attacked.

The causal fungus overwinters as pycnidia in old crop refuse; therefore the disease is more severe in second- and third-year alfalfa. Damage to first-year alfalfa probably occurs when the fungus is introduced with the seed or from nearby plantings.

Symptoms are small, brown to black spots and irregular borders that develop on stems and leaves. Spots appearing on stems often become elongated and young shoots may be dwarfed, girdled, and then eventually die. Leaf spots may merge until much of the leaflet is covered, forming large black blotches. The leaves later turn yellow or brown, wither, and drop prematurely.

The disease is usually less severe during the warm and drier summer months following the first cutting. It may become damaging again in the fall with the advent of cool, wet weather. Black stem is usually more serious when harvest is delayed. Diseased alfalfa should be cut 3 to 7 days earlier than normal to prevent additional leaf fall and to save green matter.

Common Leaf Spot

Common leaf spot is caused by the fungus *Pseudopeziza medicaginis*. The disease first develops on the lower leaves and progresses up the plant during extended moist periods with cool to moderate temperatures. The disease is more severe in the second or later cuttings, when defoliation may occur.

Symptoms usually consist of small, circular, dark brown spots about 1/16 inch in diameter on the leaflets. Tiny, light brown, disc-shaped fungus fruiting bodies form in the center of fully developed

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spots on the upper leaf surface. When spots are numerous, leaflets soon turn yellow and fall off. The causal fungus overwinters on fallen, undecayed leaves. It is not seed-borne. Several varieties have a moderate degree of resistance.

SUMMER DISEASES

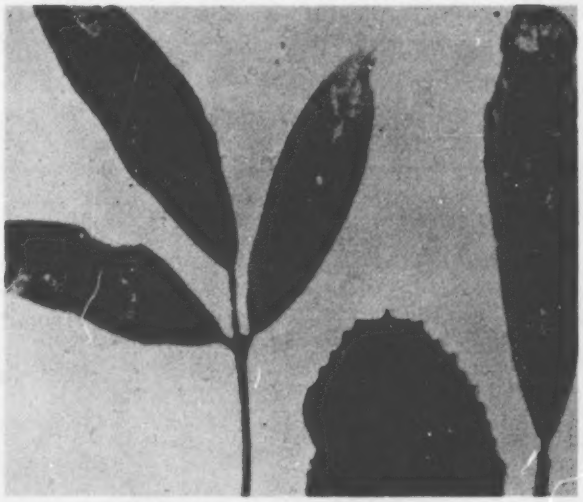
Summer Black Stem

Summer black stem is caused by the fungus *Cercospora medicaginis*. Symptoms are ashy-gray to black spots often surrounded by yellow areas on alfalfa leaves. Brown to black lesions appear on stems.

The causal fungus for summer black stem overwinters on plant residues. Infections of new shoots and healthy plants are produced by spores that are produced in special fungal fruiting structures that grow within diseased tissue.

Moisture in the form of rain or dew must be present for spores to be produced and in turn germinate and cause new infections. Such infections often occur on lower leaves or stems where air movement is reduced and plant surfaces may remain wet for long periods of time. The disease is often spread in infected seed lots. Some commercial varieties may have partial or a low level of resistance.

Stemphylium Leaf Spot



Stemphylium leaf spot is caused by the fungus *Stemphylium botryosum*. Symptoms on the leaves are oval or irregular and appear sunken. Usually the spots are dark brown with tan centers. Older spots have concentric rings, resembling a target. A large lesion can cause a leaf to drop off. During warm, moist weather severe defoliation can occur. There is no means of control.

GENERAL DISEASE PREVENTION PRACTICES

1. Grow adapted, high-yielding and, if possible, disease-resistant varieties.

2. Maintain adequate levels of potash and phosphate in the soil. Neutralize acid soils by adding lime.

3. Damage from leaf and stem diseases can be reduced if the plants are cut as soon as the disease symptoms become moderate. This will prevent excessive loss of leaves and heavy buildup of fungus inoculum which causes infection when new growth begins.

5. See your county extension director for more information on varieties, fertility practices, and the latest measures for disease prevention.

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CONTROL OF ALFALFA DISEASES

DISEASE	CAUSE	SYMPTOMS	CONTROL
Bacterial wilt	*Corynebacterium insidiosum*	See Pm-326	Resistant varieties
Phytophthora root rot	*Phytophthora megasperma*	See Pm-326	Resistant varieties.
Fusarium wilt	*Fusarium oxysporum*	See Pm-326	None.
Fusarium root rot	*Fusarium sp.*	See Pm-326	The variety Teton displays some tolerance.
Pythium seed rot and seedling blight	*Pythium sp.*	See Pm-326	None.
Nematodes	Several species of soil nematodes	See Pm-326	Plant health should be maintained by good cultural practices.
Spring black stem	*Phoma medicaginis*	See Pm-639	Timely harvesting before disease becomes too severe.
Common leaf spot	*Pseudopeziza medicaginis*	See Pm-639	Some varieties have a moderate degree of resistance.
Summer black stem	*Cercospora medicaginis*	See Pm-639	Some varieties have a degree of resistance. Seedlings in an oats overstory should have the oats harvested as soon as possible to allow air movement and more rapid drying out.
Stemphylium leaf spot	*Stemphylium botryosum*	See Pm-639	None.

DISEASES OF OATS AND WHEAT AND THEIR CONTROL

DISEASE	CAUSE	SYMPTOMS	CONTROL
Seed decay and seedling blight	Several soil-borne fungi	Occurs in cool, wet soils. Seed fails to germinate or dies before or after emergence.	Captan, Thiram, Terraclor, Maneb + Zinc, Maneb, PMA, Captan-Maneb-HCB are used as fungicide seed protectants. Use rates recommended on package.
Downy mildew	*Sclerospora macrospora*	Occurs in wet years on wetter parts of field. Infected plants remain green after healthy have ripened. Leaves are short and stiff and remain upright. Plants rarely head out.	Good soil drainage. Select seed from disease-free fields.
Powdery mildew	*Erysiphe graminis*	Small, gray spots on leaves that enlarge to form what appears to be powder over the leaf surface.	Resistant varieties and crop rotation. In greenhouse, sulfur fungicides can be used.
Scab	*Gibberella zeae*	Mostly on wheat during warm, moist weather. Diseased head will be yellow in contrast to green stem. During damp weather, a light pink color will appear at base of infected spikelet. Grain will be light and chaffy.	Wheat should not follow corn in rotation. Plow under infected residue. Plant clean seed.
Loose smut	*Ustilago sp.*	Infected head emerges from sheath as a black mass of chlamydospores. The chlamydospores are surrounded by a white membrane that disintegrates, leaving only a bare stalk.	Resistant oat varieties. Carboxin as a fungicide seed treatment. Use rates recommended on package.
Ergot	*Clavinceps purpurea*	See Pm-563	Crop rotation. Plant clean seed. Plow under refuse. Mow wild grasses before flowering.

ERGOT

Ergot, caused by the fungus *Claviceps purpurea*, attacks more than 200 grass hosts as well as cultivated cereals throughout the world (fig. 1). Ergot is most prevalent on rye but occurs to some extent each year in Iowa on barley, oats, and wheat as well as wild and cultivated grasses.

Reference to ergotism dates back to Biblical times. Records show ergot has caused serious disease epidemics of plants and animals, including man. Ergot is not as important in reducing yields of grain as it is in poisoning animals and man. Also of importance are medicinal properties of extracts made from ergot bodies or sclerotia.

Sufficient quantities of ergot make feed unsafe for livestock. In the commercial grain trade, grain is classed as "ergoty" when it contains more than 0.3 percent by weight of ergot sclerotia.

Importance to Animals

Ergot contains toxic alkaloids which cause ergot poisoning in animals. The alkaloids in ergot may vary in quantity and quality within a growing season or from year to year. Alkaloids will also vary with different grains. Because of this variation, sclerotia will vary from low to high toxicity. Generally the concentration of alkaloids in sclerotia increases with grain maturity.

Ergotism occurs in animals that are fed grain containing high levels of ergot sclerotia over an extended period of time. The toxicity of ergoty grain varies with the species and type of animal. In general, grain containing more than 0.5 percent ergot should be fed with extreme caution, and levels greater than 1.0 percent can be expected to cause problems.

The alkaloids from infested sclerotia cause contraction of the small blood vessels. Eventually the blood supply is shut off or reduced to the body appendages such as legs, ears, and tail. The surrounding tissue is deprived of nutrients and oxygen—and the tissue begins to die. This condition is more noticeable during cold weather. The damage resembles that caused by frostbite or freezing of the extremities.

In a pregnant animal, some of the alkaloids may activate contraction of the uterine muscles, resulting in abortion of the fetus. Although all alkaloids found in ergot affect small blood vessels and uterine muscles, some may have a greater effect on one than the other.

Ergot in grain may cause a decrease of milk production in lactating sows with loss of pigs from starvation. Occasionally alkaloids affect the nervous system with rapid onset of convulsions and hallucinations.

Fig. 1. Ergot on a head of wheat (left) and on rye (center). Inset: An ergot body or sclerotia.

Control

No ergot-resistant commercial cereal varieties have been developed, but the following measures will help control ergot—

- *Because ergot sclerotia do not remain viable for more than one year in soil, rotation to a non-grass will reduce ergot incidence.*
- *Use deep plowing on fields with ergot infestation. This will bury the sclerotia, which will not germinate if burried deeper than one inch.*
- *Plant only clean seed.*
- *Mow wild grass before flowering.*

Life Cycle

The most common sign of ergot is the dark purple to black sclerotia found in the head of cereals and grasses before harvest. After harvest,

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these dark bodies are evident in the grain.

Initial infection of the host plant occurs through its open flowers. Fungal spores that cause the first infection are produced from the sclerotia that remained either on or close to the soil surface from the previous year.

Following infection, the floret exudes a sweet, yellow-white substance called "honeydew." This exudate contains asexual spores called conidia.

The sweet honeydew attracts more than 40 species of insects to the infected florets. Conidia are picked up by the insects and are transmitted to healthy plants, thereby spreading the disease.

Formation of honeydew containing conidia and subsequent reinfection of healthy plants continues as long as host plants are in blossom. The conidia germinate and penetrate the floret. There they become established in the ovary and eventually form the dark sclerotium. The sclerotium is a mass of mycelium (visible, vegetative part of the fungus) that is resistant to low temperature and other adversities. Thus the fungus is allowed to overwinter in soils.

In the spring, a sclerotium germinates by forming apothecia, which are small cup-shaped, mushroom-like structures in which the sexual spores (ascospores) are produced. The ascospores are shot into the air and are carried by the wind to open flowers. The ascospores germinate, and the resultant mycelium invades the ovary tissue, produces honeydew and conidia, thereby continuing the life cycle.

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FUNGICIDE SEED TREATMENT FOR AGRONOMIC CROPS IN IOWA

A fungicide seed treatment is the application of a fungicide to the seed to protect it from rot or decay caused by disease-causing microorganisms in the soil, on the seed, or in the seed (smuts only).

REASONS TO TREAT SEED WITH A FUNGICIDE

Unpredictability of Weather After Planting

Soil conditions may become adverse for optimum seed germination and growth of seedlings. For example, the weather may be cool and wet or just remain wet for various periods of time after seed has been planted. Under these conditions, seeds are slow to germinate and emerge; but soil microorganisms grow well and are more likely to infect seed than under warmer and drier soil conditions. A fungicide protects the seed from potential infectious soil microorganisms until soil conditions are favorable for rapid seed germination and growth. This is the most important reason for treating seed with a fungicide.

Diseased Seed

Seed may become infected by disease-causing microorganisms during the growing season. This is most likely to occur during periods of excessive moisture prior to harvest. The consequence of infected seed is poor germination when planted the following crop season. A seed protectant fungicide is most effective if the disease-causing microorganism is on the outside of the seed. It is of little or no benefit when the microorganism is already established inside the seed. An exception to this is the use of systemic fungicides to control loose smut of small grains where the mycelium of the causal fungus is inside the seed.

Poor Quality Seed

Physical damage to seed, such as cracked or split seed coats, may occur due to extended alternating wet and dry weather at harvest time or improper adjustment of harvesting machinery. Soil microorganisms may grow into these cracks when the seed is sown without having to directly penetrate the seed coat itself. A fungicide will act as a protective covering over these cracks and splits.

Carryover Seed

Seed produced two or more years prior to planting may lack vigor and not germinate properly. Soybeans and corn in particular are affected. Such seed as it lies in the soil without germinating is subject to infection and eventual decay by soil microorganisms in contrast to healthy seed that is able to germinate rapidly. A fungicide seed treatment will prevent some of this decay and produce a better stand.

OTHER FACTORS TO CONSIDER

Indefinite Persistence

Seed protectant fungicides do not persist indefinitely in soil. But, depending upon soil moisture conditions and temperatures, they will tend to lose their efficacy in 10 to 14 days. The more soil moisture present, the quicker the fungicide will break down. Seed may be pretreated several months prior to planting with little or no loss in fungicide efficiency providing the treated seed is dry and properly stored.

Effective as Seed Protectants Only

Fungicide seed protectants do not control other plant diseases that may occur during the growing season. For example, the fungicide will protect only the seed and a limited portion of a newly germinated seedling, but will not prevent root rots or above-ground plant diseases. Additionally, the germinated seedling may be subject to pre- and post-emergence damping-off if soil conditions (such as wet and cool) remain favorable for infection by soil pathogens.

Compatibility With Inoculum

Fungicides may harm inoculum applied to seed. Inoculating seed with nitrogen-fixing bacteria should be done as close to planting time as possible with the fungicide applied to the seed anytime before the inoculum is applied.

Treat All Seed

It may even be a good idea to treat seed that has a high rate of germination. A high rate of germination does not insure high vigor under soil conditions adverse to plant

(Continued on page 4)

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FUNGICIDE	TRADE NAME AND MANUFACTURER(S)	FORMULATION[1]	CROPS AND DISEASES CONTROLLED							
			Alfalfa	Barley	Corn	Oats	Rye	Sorghum	Soybeans	Wheat
Busan	Busan 30; Buckman	EC		Covered smut, Helminthosporium stripe	Seed rot, seedling disease	Seed rot, seedling blights, loose and covered smuts				Seed rot, seedling blight, bunt
Captan	Several names; Chevron, Stauffer	WP, dust	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight	Seed rot, seedling blight
Carboxin	Vitavax 75; Uniroyal	WP		Seed rots, seedling diseases, stripe smut, loose smut, covered smuts (with Thiram)		Seed rot, seedling diseases, loose and covered smuts				Seed rot, seedling diseases, flag smut, loose smut, common bunt (with Thiram)
Chloranil	Spergon; Uniroyal	WP, dust	Seed rot, seedling disease		Seed rot, seedling disease	Seed rot, seedling diseases		Seed rot, seedling diseases	Seed rot, seedling diseases	
Chloroneb	Demosan; DuPont								Pre and post[2] emergence damping-off, seedling blights, (**Pythium sp. Rhizoctonia sp.**, and **Sclerotium rolfsii**)	
Copper carbonate	Malachite; Cities Service, Harshaw	WP, dust						Kernel smut		Bunt
Copper oxide	Perecot, Perenox, yellow cuperocide; Phelps Dodge	WP, dust	Damping-off							
Dexon	Dexon; Chemagro, Mobay	WP				Damping-off (Pythium)		Covered kernal smut, damping-off (Pythium)		
Dichlone	Phygon; Uniroyal	WP, dust	Seed decay, damping-off		Seed decay, damping-off			Seed decay, damping-off		
Difolatan	Difolatan; Chevron	WP, dust flowable			Damping-off			Damping-off		
Formaldehyde	Formalin; Allied, Celanese, DuPont, Monsanto, Tenneco, Union Carbide	liquid		Covered and loose smut		Covered and loose smut	Stem smut	Loose and covered kernel smuts		(Durum and spring). Covered smut, flag smut

Maneb	Dithane M-22, Manzate (D), Maneb 80, Vancide, (partial list); BASF Wyandotte, DuPont	WP,[3] dust		Covered and false loose smuts, damping-off, seedling blight	Damping-off seed rots, seedling blights	Damping-off, seed rots, seedling blights, smuts	Bunt, damping-off, seed rots, seedling blights	Covered kernel, smut, damping-off seed rots, seedling blights	Damping-off, seed rots, seedling blights	Bunt, damping-off, seed rots, seedling blights
Paraformaldehyde	Paraformaldehyde; Celanese	Dust		Covered smut		Smut				
PCNB	Terraclor; Olin	WP, EC, dust		Covered smut	Seedling disease complex	Smut		Seedling disease complex, covered kernel smut	Seedling disease complex	Bunt, seedling disease complex
Polyram	Polyram; FMC	WP, dust		Covered smut seed rots, seedling diseases		Covered smut, seed rots, seedling diseases		Covered kernel smut, seed rots, seedling diseases		Bunt, seed rots, seedling diseases
Terrazole[4]	Terrazole; Olin	WP, EC		Covered smut, seedling disease complex	Seedling disease complex			Seedling disease complex	Seedling disease complex	Seedling disease complex, stinking smut
Thiram	Arasan (also several other names); DuPont, Merck	WP, dust, liquid		Damping-off seed decay, seedling blight, covered smut	Damping-off, seed decay, seedling blights	Damping-off, seed decay, seedling blight	Damping-off, seed decay, seedling blight, covered smut	Damping-off, seed decay, seedling blight, loose and covered smut	Damping-off, seed decay, seedling blight	Damping-off, seed decay, seedling blight, bunt
Zineb[5]	Zineb; BASF Wyandotte, FMC, Rohm and Haas	WP, dust	Seed rots, seedling rots	Seed rots, seedling rots	Seed rots, seedling rots	Seed rots, seedling rots		(hulled) Seed rot, seedling rot	Seed rot, seedling rots	Seed rot, seedling rots
Zinc-ion-Maneb	Dithane M-45, Manzate 200, Rohm and Haas, DuPont	WP, dust[3]		Seed decay, seedling blights, covered smut	Seed decay, seedling blight	Seed decay, seedling blight	Seed decay, seedling blight, covered smut	Seed decay, seedling blight		Seed decay, seedling blight, covered smut

[1] EC = emulsifiable concentrate; WP = wettable powder; slurries can be made from WP or they may be used as dust or planter box treatment.

[2] Applied as an in-furrow soil treatment at time of planting; soybean seed must be pretreated with Thiram.

[3] Only dust formulation is used for agricultural seed treatments.

[4] For agricultural seed treatment, used in combination with PCNB.

[5] Registered only for use with captan.

growth. However, keep in mind that when growing conditions favor the crop, a fungicide seed treatment may produce no benefits. Application of a fungicide seed protectant should be thought of as an insurance policy. Nobody wants to collect on it but it's nice to have if something goes wrong.

SAFETY RULES

Treated Seed Is for Planting Only

Seed treated with a fungicide cannot be used for any purpose other than planting. Treated seed that has gotten into commercial food or feed channels may cause condemnation of the entire lot or shipment. Do not use seed for feed or food, even after it has been stored for months or years.

Treated seed should be stored in clearly marked containers. Thoroughly clean sacks or other containers used for storing treated seed before using for other purposes.

To avoid having treated seed left over after sowing, buy or treat a little less seed than will be needed for the acreage to be planted. Finish sowing with untreated seed. This will eliminate any problems with stored seed. Treated seed that is not sown must be destroyed.

Phytotoxicity

Most fungicides when over-applied or otherwise misapplied will cause phytotoxicity. Be sure to carefully read the instructions on the label.

Irritation to Humans

Some fungicides may be irritating to certain individuals handling them, particularly during a planter box treatment. Be careful. Wear rubber gloves, a properly fitting mask to avoid fungicide dust inhalation and clothing that covers the skin to avoid dust contact. Most important. . .READ THE LABEL.

SEED TREATMENT METHODS

Fungicide seed treatments may be applied commercially as dust, spray or slurry; or they may be applied at the time of planting as a planter box treatment. The cost is minimal, averaging a few cents per acre. All fungicides used for seed treatment contain a dye so that treated seed may be easily recognized.

Slurry Application

The fungicide dust is suspended in a small quantity of water. This is applied to the seed in a "slurry treater" which coats the seed with the fungicidal slurry. The water evaporates, leaving the seed coated with fungicide.

Spray or Liquid

Such treatments are applied in either mist-type or ready-mix treating machines. In the mist type, the liquid (either undiluted or mixed with a small amount of water) is applied to seed as a mist. In ready-mix type, the liquid is applied directly to seed in the rotating mixer.

Planter Box Treatment

A measured amount of fungicide is mixed together with a pre-determined weight or volume of seed in the drill, planter box or in an outside container, then placed in the planter. Planter box treatments do not always work well with air planters. It is best to use commercially treated seed.

Fungicides used for seed treatment on selected crops are listed on pages 2 and 3. This list is not intended to be comprehensive and implies no endorsement of listed materials nor criticism of materials not listed. Read the directions on the label and follow instructions listed for rates, handling and storage of treated seed.

. . .AND JUSTICE FOR ALL

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SPECIAL THINGS TO CONSIDER WHEN APPLYING CROP FUNGICIDES

Preharvest and Re-entry Intervals

Many pesticides are restricted by a minimum time from last application to harvest. This time requirement is known as the *preharvest interval.* The label and Extension pest control publications furnish needed information on this restriction. Preharvest intervals should be carefully observed to prevent harvesting an illegally contaminated product.

The minimum time between applying a chemical and workers entering the treated area is known as the *re-entry interval.* This restriction is presently required only for some pesticides that are highly toxic to warm-blooded animals. Re-entry intervals should be carefully observed.

Phytotoxicity

When a chemical burns a plant to which it is applied, it is said to be phytotoxic (plant toxic). If the plant is a weed and the chemical a herbicide, the result is good, but usually the word *phytotoxic* is used when a pesticide adversely affects plants. Phytotoxicity may occur due to drift to nontarget plants, excessive rates, mixing of chemicals that are not toxic when used alone, and using chemicals in a more concentrated form than desirable. Certain weather patterns may cause or increase the amount of phytotoxicity. Exceptionally bright, hot, dry weather following a period of cooler weather is such a situation. It is not unusual to get some phytotoxicity when using pesticides in accordance with recommended practices. It is unusual to have a severe phytotoxicity problem under these circumstances.

To avoid phytotoxicity, apply chemicals within recommended rates. Do not mix chemicals unless the label indicates it is all right. Time applications according to recommendations. Use recommended water rates.

Residues

The amount of a pesticide that remains after application is the residue. The ideal pesticide would be residual enough to control a pest for the length of time needed and then break down into completely harmless chemicals. Unfortunately, this is not the case with most pesticides. The long residual nature of chlorinated hydrocarbons is one of the main reasons they are being used less. Usually a tolerance is set for each chemical that is registered on a crop. It is expressed in parts per million (ppm). The residue that remains on the harvested crop cannot exceed the tolerance that was set when the pesticide was labeled. This has a direct relationship to the preharvest interval. Registered and recommended rates should not be exceeded because the residue may exceed the legal tolerance.

The residue of pesticides in soils may create problems. If a chemical is legally used on one crop and it is not legal on the succeeding crop, an illegal residue may result. See the section on contamination of soil and water for additional information.

Environmental Contamination

a. Nontarget Injury and Community Problems

Care should be exercised not to contaminate nontarget areas when applying a pesticide. This is particularly true of food and feed crops, bodies of water, apiaries, woodlands, and urban areas. Information on the least hazardous recommended chemical to use where there is danger of contamination can be obtained from county extension offices.

Drift is probably the chief culprit contributing to contamination of nontarget areas. Pesticides should be applied when there is little or no wind. Under no conditions should pesticides be applied if wind exceeds 10 miles per hour. Using extremely low volume and air delivery spraying systems increases the problems of drift. Some pesticides may badly damage or completely destroy some crops if they are allowed to drift onto them.

Such precautions as spraying when there is little or no wind, using the least volatile forms of dangerous chemicals, and avoid breaking spray into very fine particles will help prevent these problems.

b. Contamination of Soil and Water

When pesticides are being used, care should be taken to prevent undue contamination of the soil and bodies of water. Select the pesticide that is least likely to cause contamination problems.

For example, carefully mark each swath in order to avoid a double application. Some herbicides and long residual insecticides may have a carryover effect if excessive rates are used. This could contaminate or destroy subsequent crops.

When bodies of water are in close proximity to the area being treated, select the recommended chemical that would be least likely to contaminate the water. Apply the chemical when there is no wind or when the wind drifts the chemical away from the water. Do not apply the chemical when heavy washing rain is probable.

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